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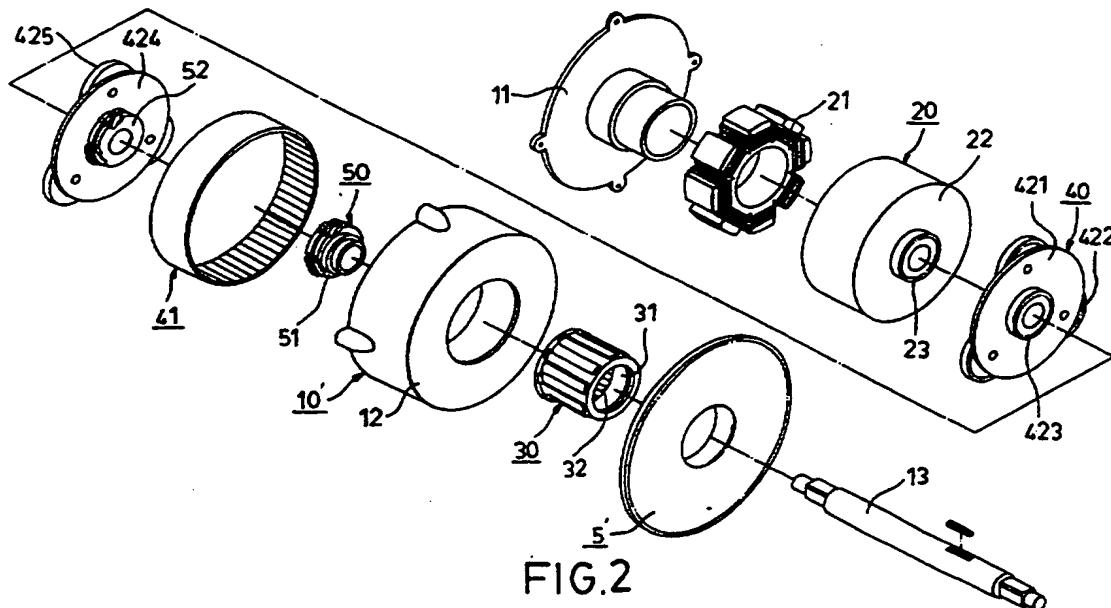
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EP 0559231 A1 US 4402374 A

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Online databases: EDOC, WPI

(54) Bicycle equipped with electrical driving device

(57) An electrical driving device for a bicycle comprises a motor 20 and a speed reduction unit 10'. The motor output shaft 23 is in the form of a fixed driving gear and is coaxial with the front sprocket crank shaft 13 so as to minimize the loss of the power transmitted from the motor 20 to the crank shaft 13. The speed reduction unit 10' comprises a planetary gear system 40 and ring gear 41, and a ratchet unit 50 which acts as a unidirectional transmission to prevent the crank shaft 15 from driving the motor 20.



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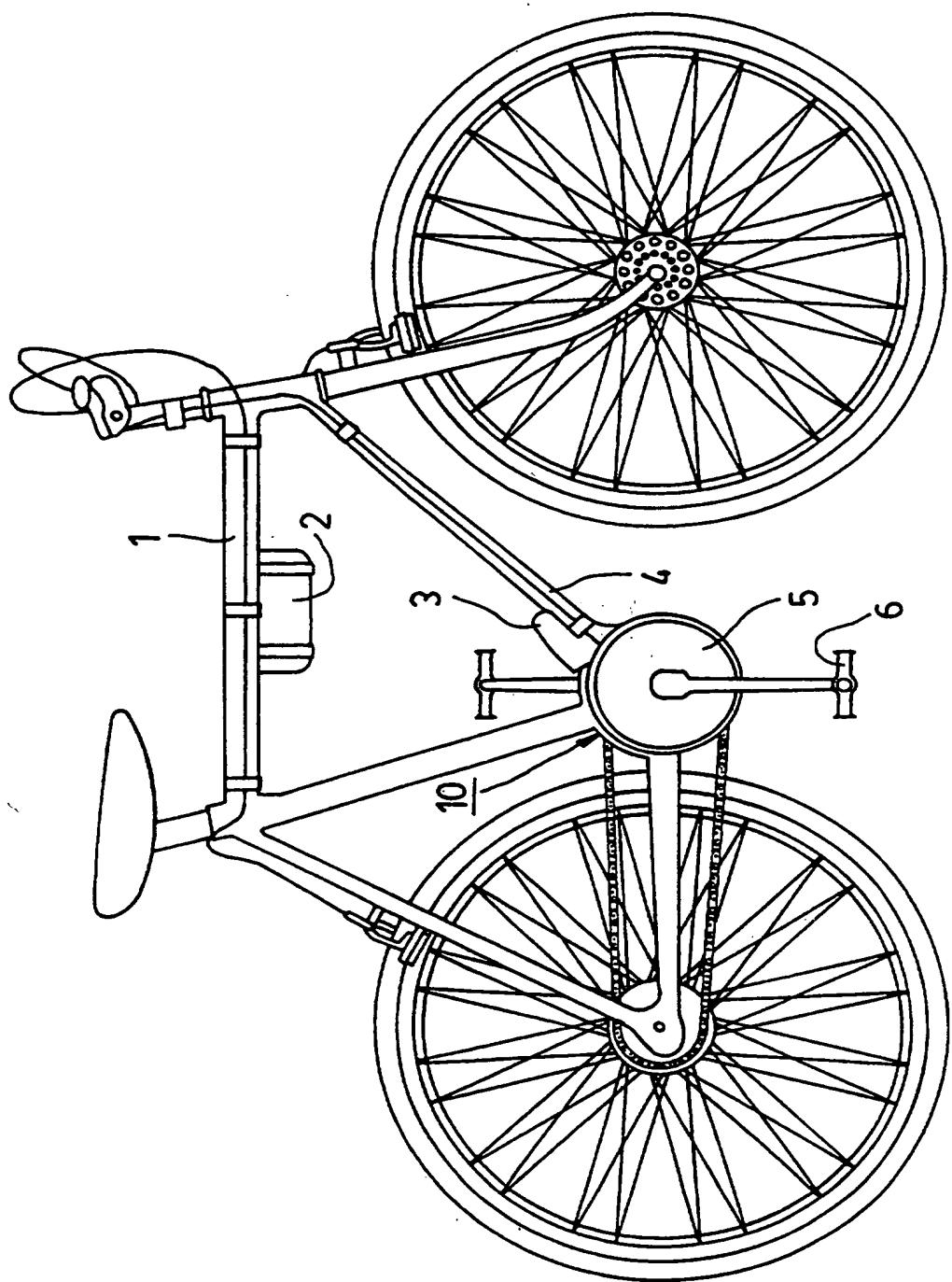
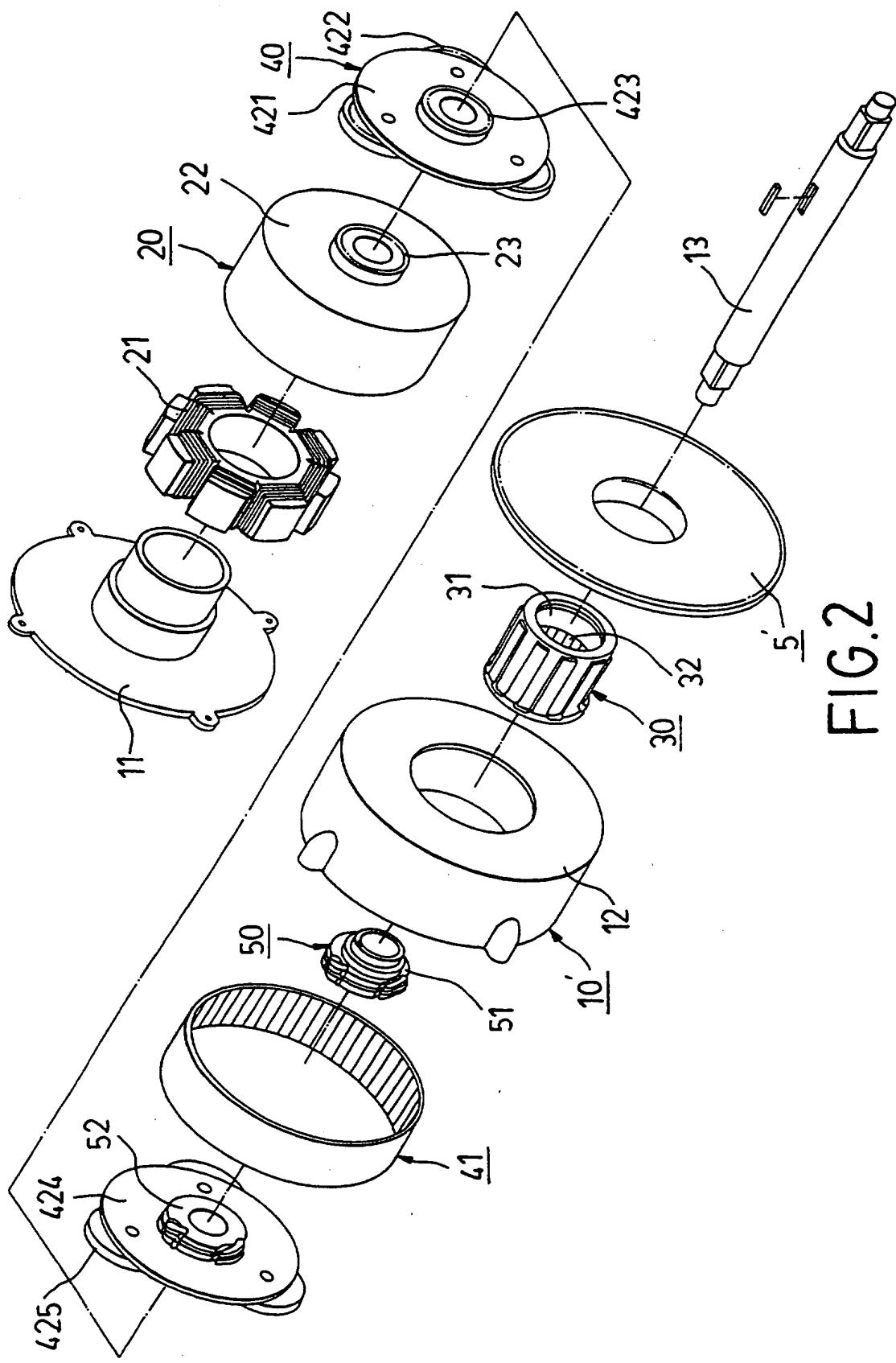


FIG. 1

**FIG. 2**

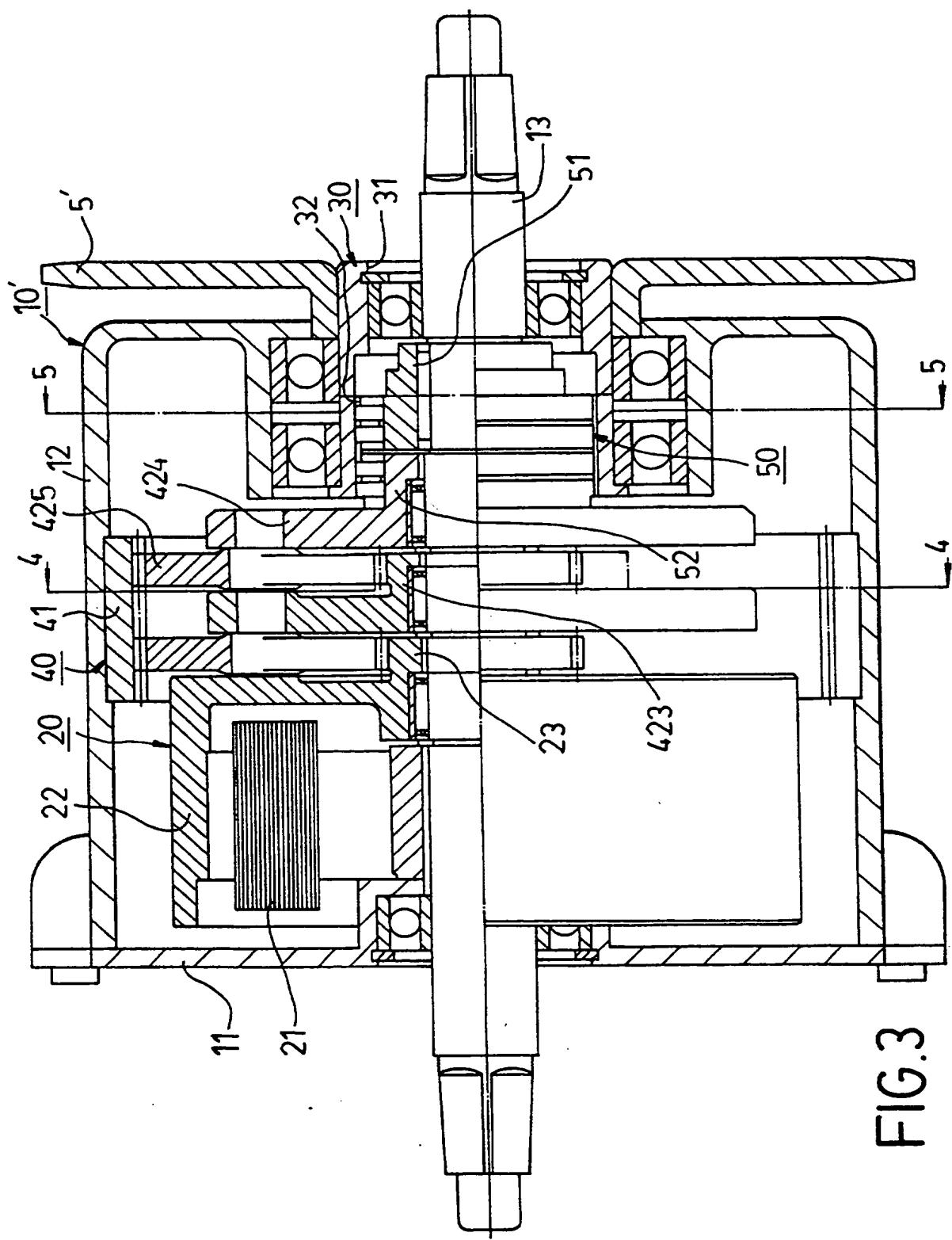


FIG. 3

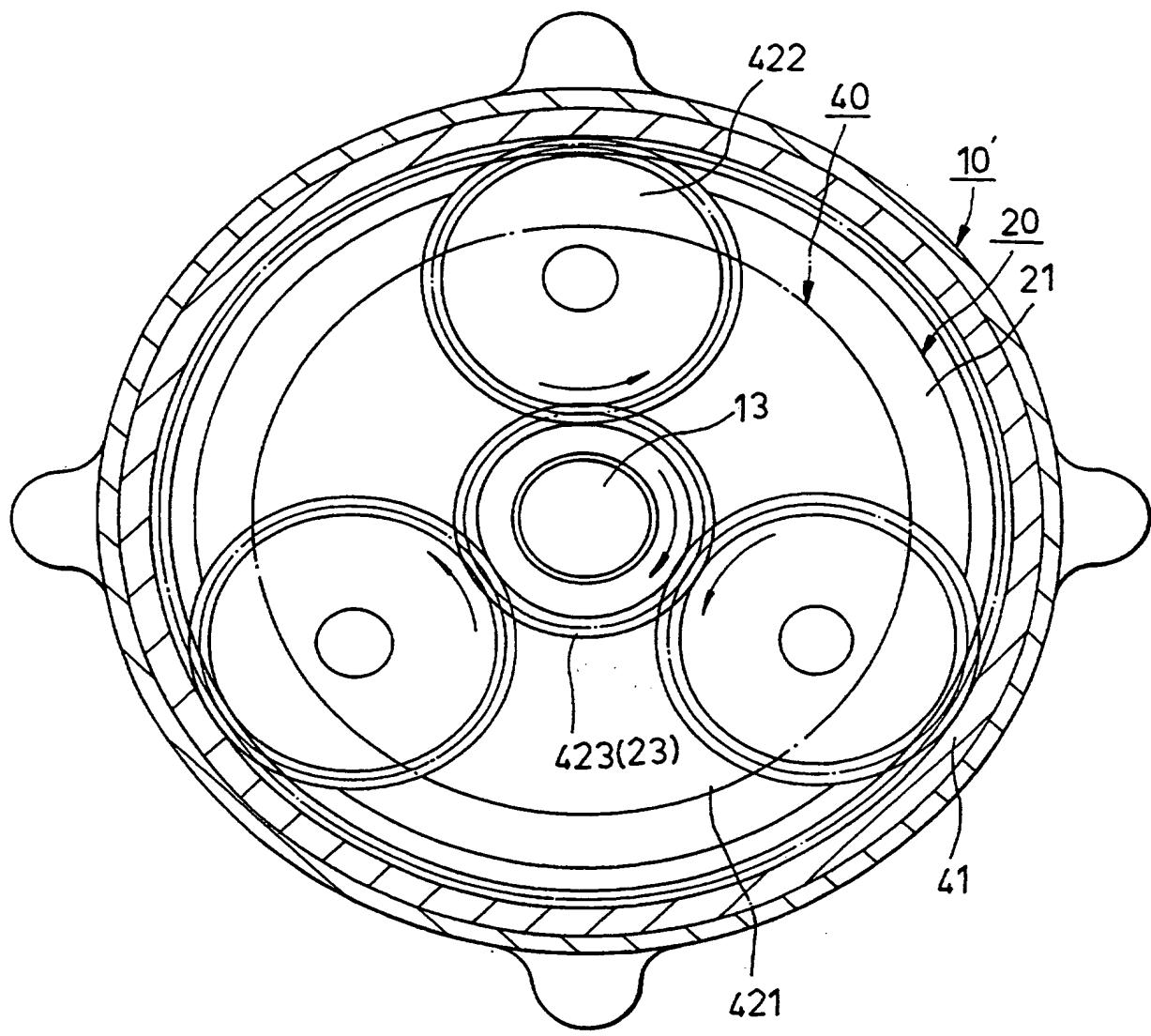


FIG.4

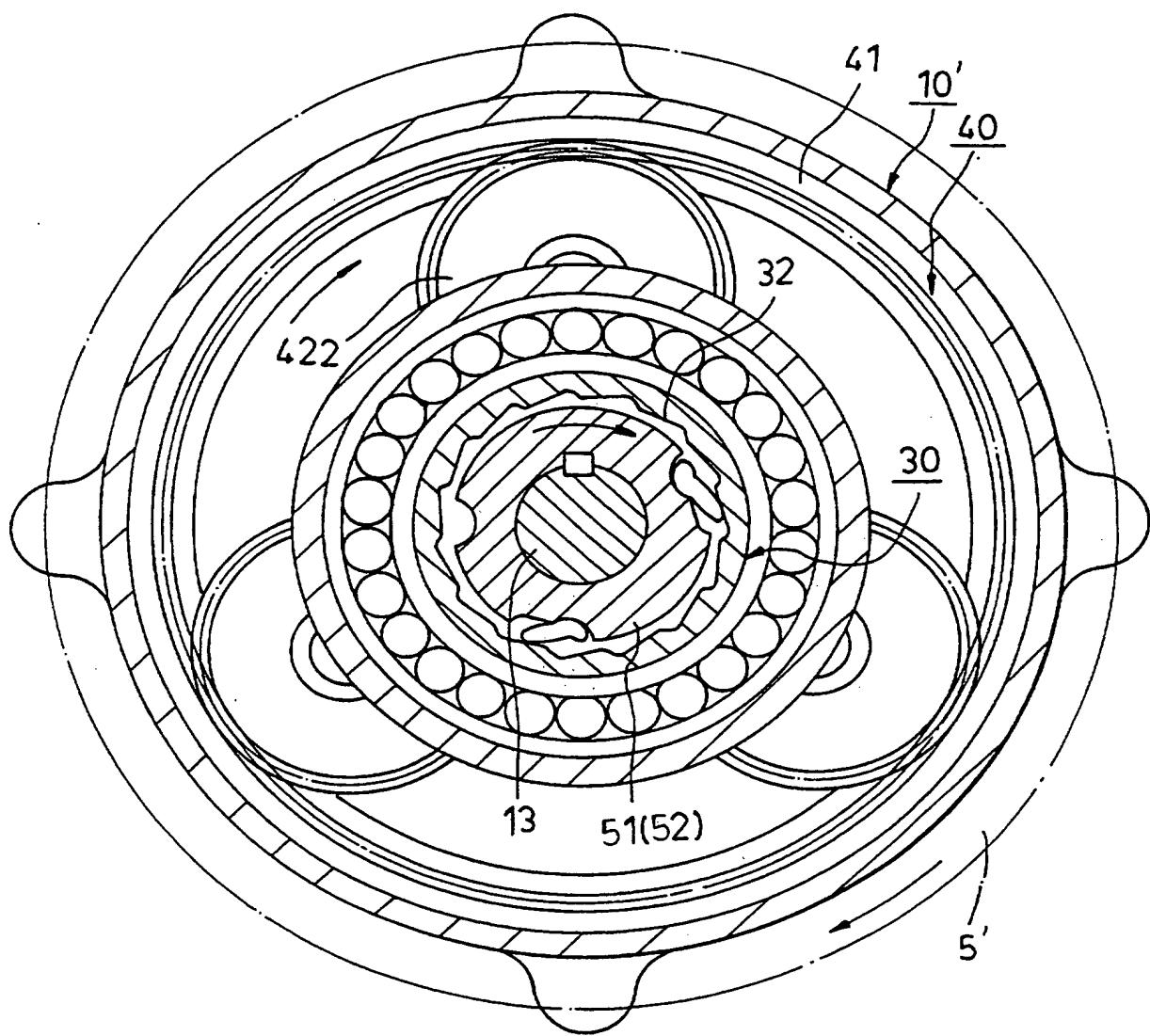


FIG.5

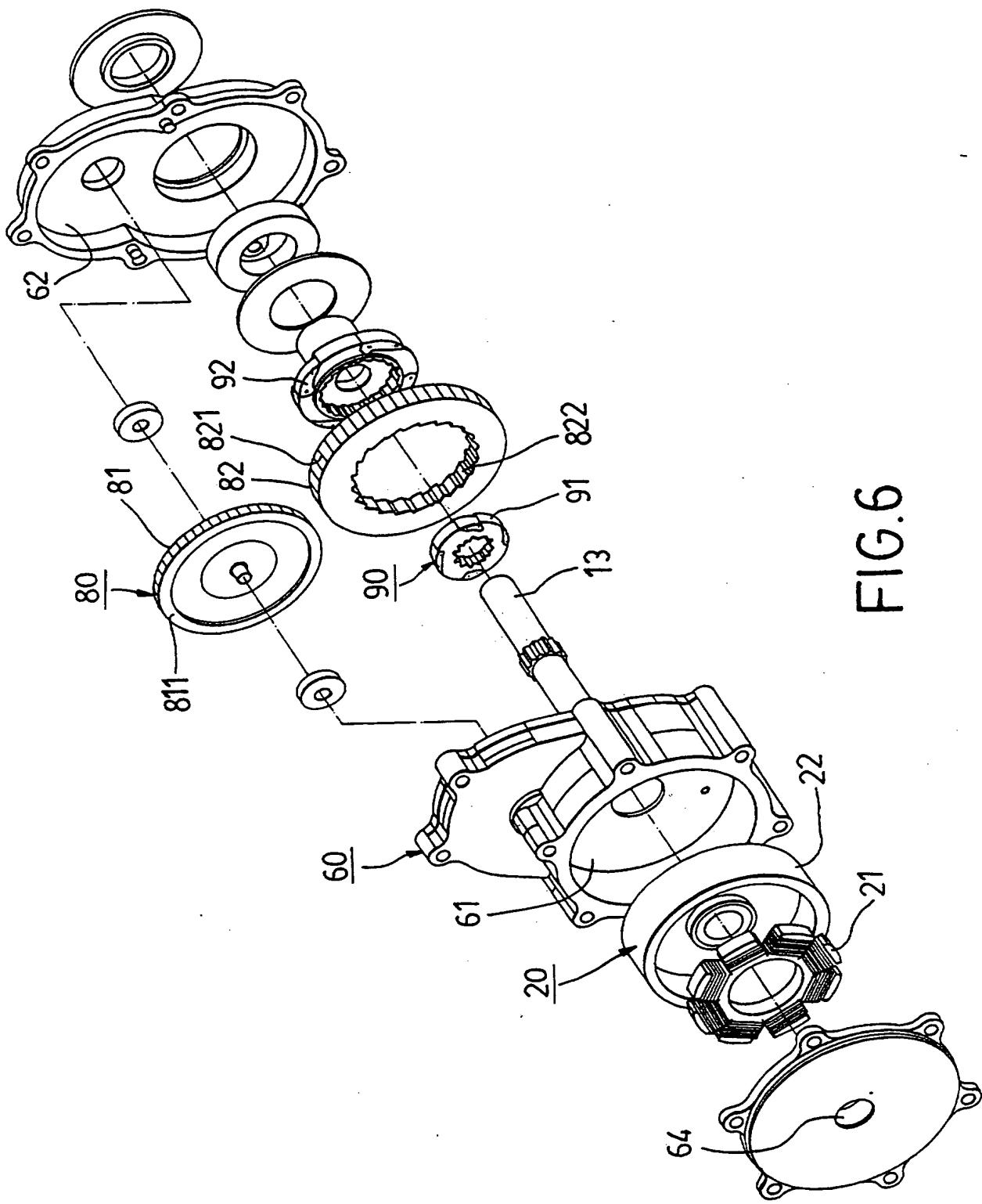


FIG. 6

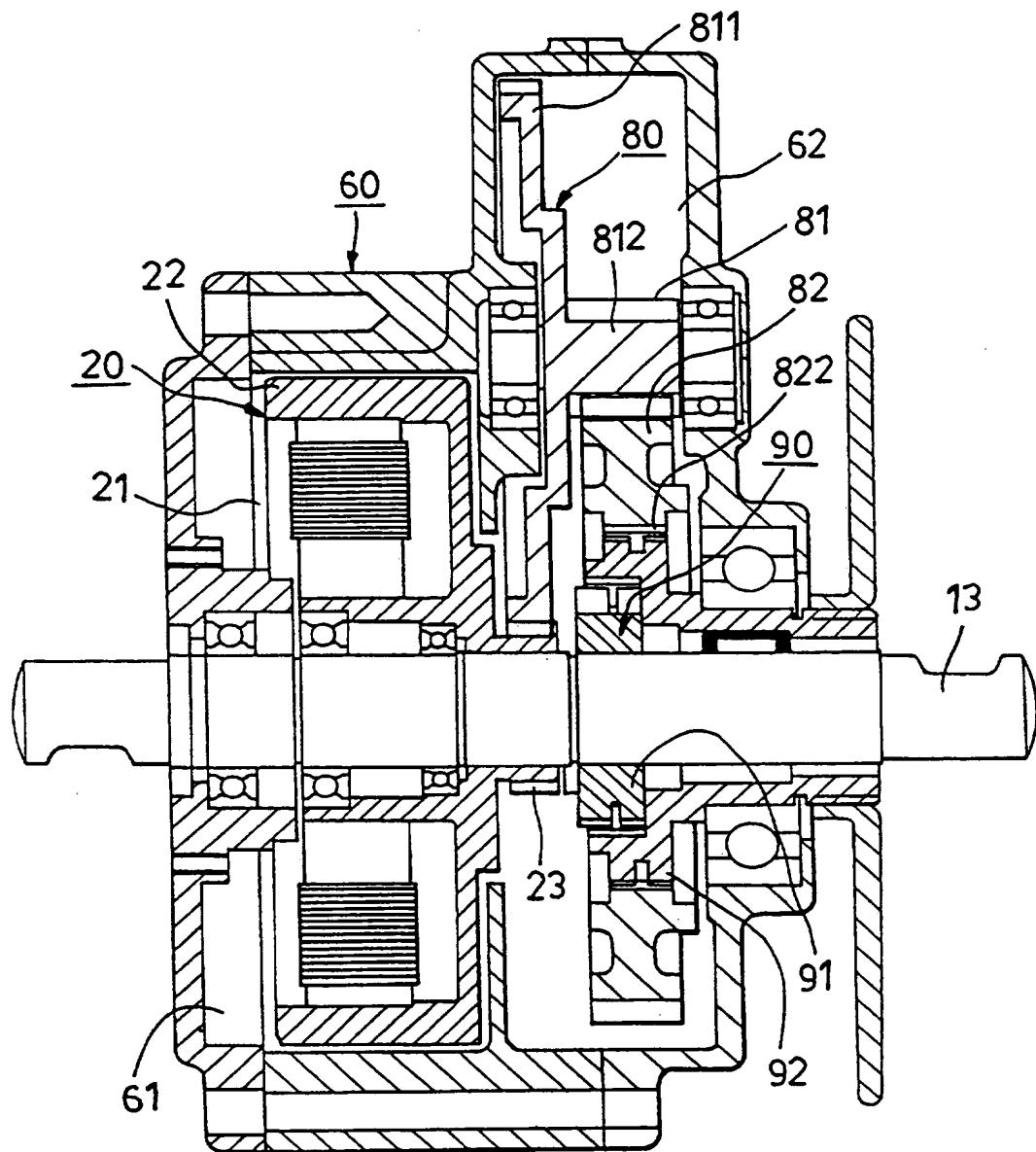


FIG.7

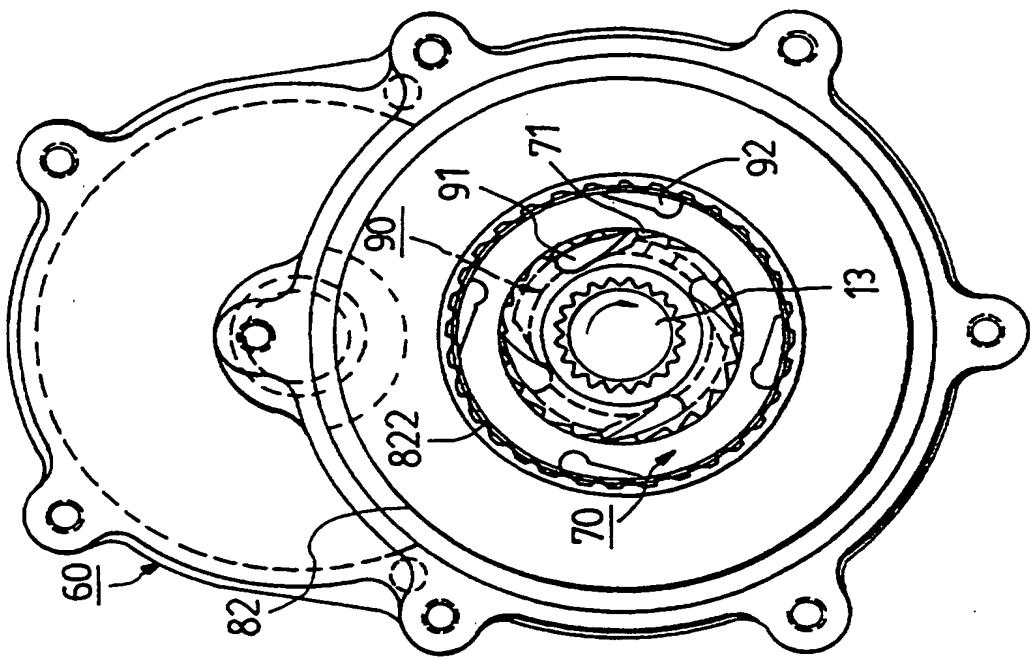


FIG. 8B

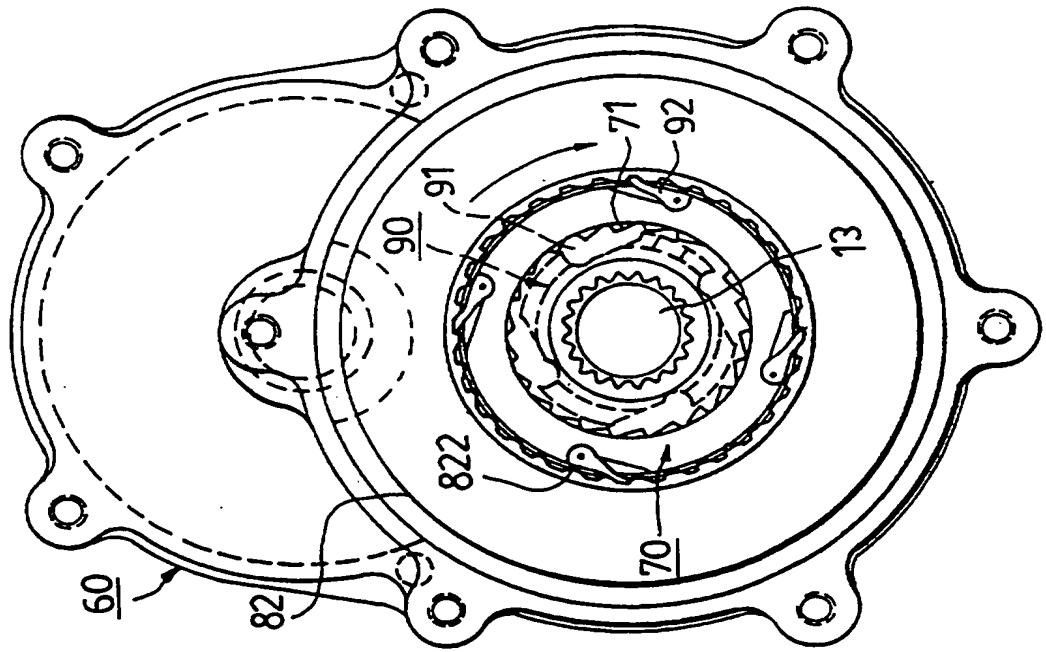


FIG. 8A

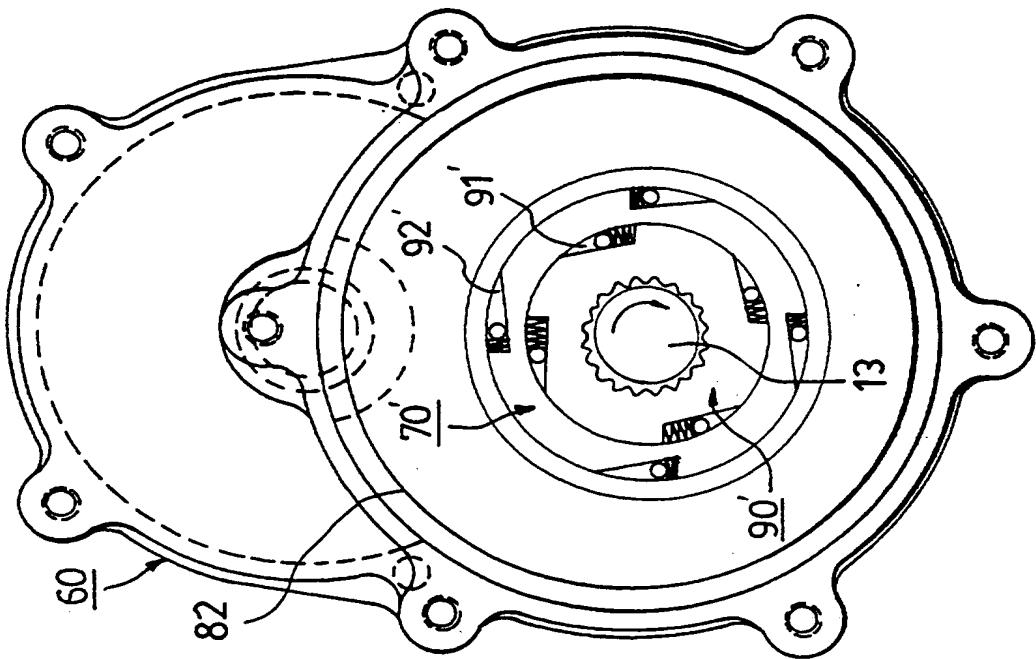


FIG.9B

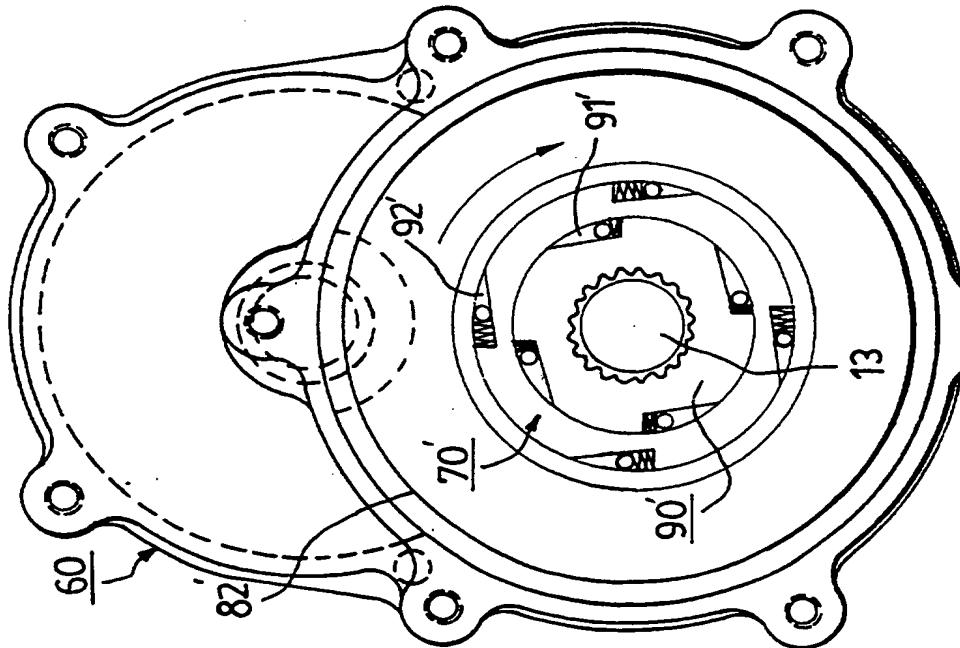


FIG.9A

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BICYCLE EQUIPPED WITH ELECTRICAL DRIVING DEVICE

This invention relates to a bicycle, more particularly to an improved electrical driving device for a bicycle which can transfer efficiently rotation of a motor to a front sprocket.

The improvement of this invention is directed to a conventional bicycle shown in Fig. 1, which has a frame unit 1, and an electrical driving device which includes a motor 2 disposed on the upper portion of the frame unit 1, a switch 3 installed on the lower portion 4 of the frame unit 1 so as to activate the motor 2, and a speed reduction unit 10 transferring rotation of the motor shaft of the motor 2 to the front sprocket 5. A pedal unit 6 is provided to drive the front sprocket 5. The power is transmitted from the motor 2 to the front sprocket 5 by a worm and worm gear assembly (not shown). Because the axes of the worm and the worm gear are perpendicular, a substantial portion of the power is lost.

An aim of this invention is to provide a bicycle with an improved electrical driving device wherein the power can be transmitted effectively from a motor to a front sprocket.

According to this invention, a bicycle includes a frame unit, a front sprocket, a crank shaft for driving the front sprocket, a pedal unit for activating the crank shaft, and an electrical driving device which

includes a motor installed on the frame and having a
motor shaft, and a speed reduction unit transferring
rotation of the motor shaft to the crank shaft, in such
a manner that the crank shaft rotates at a speed
5 smaller than that of the motor shaft, and that the
crank shaft cannot drive the motor shaft. The motor
shaft is coaxial with and adjacent to the front
sprocket so as to minimize the loss of the power
transmitted from the motor to the front sprocket.

10 Other features and advantages of this invention
will become apparent in the following detailed
description of the preferred embodiments of this
invention with reference to the accompanying drawings,
in which:

15 Fig. 1 illustrates a conventional bicycle;

Fig. 2 is an exploded view of an electrical
driving device for a bicycle according to this
invention;

20 Fig. 3 is a sectional view showing the electrical
driving device of this invention;

Fig. 4 is a sectional view taken along line 4-4 in
Fig. 3;

Fig. 5 is a sectional view taken along line 5-5 in
Fig. 3;

25 Fig. 6 is an exploded view of another electrical
driving device for a bicycle according to this
invention;

Fig. 7 is a sectional view of the electrical driving device shown in Fig. 6;

Figs. 8A and 8B illustrate a ratchet arrangement which functions as a unidirectional clutch for use in
5 the electrical driving device shown in Fig. 6; and

Figs. 9A and 9B illustrate a spring-biased roller clutch arrangement which functions as a unidirectional clutch for use in the electrical driving device shown
in Fig. 6.

10 Before this invention is disclosed in greater detail, same reference numbers will be used to denote like elements throughout the specification.

Because the improvement of this invention is directed to the electrical driving device of a bicycle,
15 the description concerning the remaining portion of the bicycle will be omitted.

Referring to Figs. 2, 3, 4 and 5, an electrical driving device of this invention has a speed reduction unit 10' and a motor 20 which has an annular stator 21 and a tubular rotor 22 surrounding the stator 21 and provided with a fixed driving gear 23 which serves as a
20 motor shaft or an output shaft for the motor 20.

The speed reduction unit 10' has a casing unit which consists of a tubular left half 11 and a tubular right half 12 and which is fixed on the bicycle frame
25 (not shown) so as to journal crank shaft 13 therein and so as to accommodate the motor 20 therein.

The speed reduction unit 10' further has a planetary gear system 40 which includes:

- (1) an annular left carrier 421 positioned within the right half 12 of the casing unit,
- 5 (2) several left planet gears 422 mounted pivotally on the left carrier 421 and meshing with the driving gear 23 of the rotor 22,
- 10 (3) a ring gear 41 fixed on the right half 12 of the casing unit and meshing with the left planet gears 422 so as to rotate the left carrier 421 in a direction the same as that of the rotor 22,
- 15 (4) a driven gear 423 fixed on the left carrier 421,
- (5) a right carrier 424, and
- 15 (6) several right planet gears 425 mounted pivotally on the right carrier 424 and meshing with the driven gear 423.

A ratchet unit 50 connects the right carrier 424 to the crank shaft 13 so as to transfer rotation of the right carrier 424 to the crank shaft 13 and so as to prevent the crank shaft 13 from driving the right carrier 424, thereby performing a unidirectional transmission between the right carrier 424 and the crank shaft 13. As illustrated, the ratchet unit 50 includes a right pawl member 51 fixed on the crank shaft 13, a left pawl member 52 fixed on the right carrier 424, and a ratchet sleeve 30 which is connected

securely to the inner periphery of a front sprocket 5' (see Fig. 3) and which has an inner wall 31 provided with a ratchet-toothed section 32 engaging the right pawl member 51 and the left pawl member 52.

5 Accordingly, the crank shaft 13 rotates at a speed smaller than that of the motor shaft or the driving gear 23.

10 It can be appropriated that the motor shaft 23 is coaxial with the crank shaft 13, so that the power loss can be minimized.

15 Figs. 6 and 7 show another embodiment of the electrical driving device of this invention which has a casing unit 60 and a motor 20. The casing unit 60 includes a tubular main casing defining a left chamber 61, an annular right casing defining a right chamber 62, and an annular left casing 64. The motor 20 includes a stator 21 and a rotor 22 surrounding the stator 21 and provided with a fixed driving gear 23, which are disposed within the casing unit 60.

20 A speed reduction unit 80 includes a gear member 81 and a gear ring 82 which are journalled in the casing unit 60. The gear member 81 includes a large gear 811 meshing with the driving gear 23 of the rotor 22, and a small gear 812 connected fixedly and coaxially to the large gear 811 and having a diameter smaller than that of the large gear 811. The gear ring 82 has a gear-toothed outer periphery 821 meshing with

the small gear 812, and a ratchet-toothed inner periphery 822.

A ratchet unit 90 connects the small gear 812 to a crank shaft 13 so as to transfer rotation of the small gear 812 to the crank shaft 13 and so as to prevent the crank shaft 13 from driving the small gear 812, thereby performing a unidirectional transmission between the small gear 812 and the crank shaft 13.

As illustrated, the ratchet unit 90 includes an annular pawl member 91 sleeved fixedly on the crank shaft 13, and an annular ratchet member 92 having an outer peripheral pawl section engaging the ratchet-toothed inner periphery 822 of the gear ring 82, and a ratchet-toothed inner periphery engaging the outer peripheral pawl section of the pawl member 91.

The ratchet unit 90 of Figs. 6 and 7 may be replaced with the ratchet arrangement 90 of Figs. 8A and 8B or the spring-biased roller clutch arrangement 90' of Figs. 9A and 9B.

Referring to Figs. 8A and 8B, the front sprocket (not shown) is fixed to a sleeve 70 which has inwardly projecting ratchet teeth 71. As illustrated, the ratchet arrangement 90 includes an inner ratchet wheel and pawl assembly 91 interposed between the crank shaft 13 and the sleeve 70, and an outer ratchet wheel and pawl assembly 92 interposed between the sleeve 70 and the inner periphery 822 of the gear ring 82, in such a

manner that either the crank shaft 13 or the gear ring 82 can drive the sleeve 70 when rotating in a clockwise direction indicated by the arrowheads, and that no rotation can be transferred between the crank shaft 13
5 and the gear ring 82.

Referring to Figs. 9A and 9B, the front sprocket (not shown) is fixed to a sleeve 70'. As illustrated, the spring-biased roller clutch arrangement 90' includes an inner roller clutch assembly 91' interposed between the crank shaft 13 and the sleeve 70', and an outer roller clutch assembly 92' interposed between the sleeve 70' and the gear ring 82, in such a manner that either the crank shaft 13 or the gear ring 82 can drive the sleeve 70' when rotating in a direction indicated by the arrowheads, and that no rotation can be transferred between the crank shaft 13 and the gear ring 82.
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CLAIMS:

1. A bicycle including a frame unit, a front sprocket, a crank shaft for driving the front sprocket, a pedal unit for activating the crank shaft, and an electrical driving device which includes a motor installed on the frame and having a motor shaft, and a speed reduction unit transferring rotation of the motor shaft to the crank shaft, in such a manner that the crank shaft rotates at a speed smaller than that of the motor shaft, and that the crank shaft cannot drive the motor shaft, wherein the improvement comprises:
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the motor shaft being coaxial with the front sprocket.

2. A bicycle as claimed in Claim 1, wherein the motor includes a stator and a rotor surrounding the stator and provided with a fixed driving gear which serves as the motor shaft, the speed reduction unit including:
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a casing unit fixed on the frame so as to permit the crank shaft to be journalled therein, the motor being disposed within the casing unit;
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a left carrier positioned in the casing unit;

several left planet gears mounted pivotally on the left carrier and meshing with the driving gear of the rotor;

25 a ring gear fixed on the casing unit and meshing with the left planet gears so as to rotate the left carrier in a direction the same as that of the rotor;

a driven gear fixed on the left carrier;
a right carrier;
several right planet gears mounted pivotally on
the right carrier and meshing with the driven gear; and
5 a ratchet unit connecting the right carrier to the
crank shaft so as to transfer rotation of the right
carrier to the crank shaft and so as to prevent the
crank shaft from driving the right carrier, thereby
performing a unidirectional transmission between the
right carrier and the crank shaft.
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3. A bicycle as claimed in Claim 1, wherein the motor
includes a stator and a rotor surrounding the stator
and provided with a fixed driving gear which serves as
the motor shaft, the speed reduction unit including:
15 a casing unit fixed on the frame so as to permit
the crank shaft to be journalled therein, the motor
being disposed within the casing unit;
a large gear mounted rotatably in the casing unit
and meshing with the driving gear;
20 a small gear coupled fixedly and coaxially with
the large gear and having a diameter smaller than that
of the large gear;
a ratchet unit connecting the small gear to the
crank shaft so as to transfer rotation of the small
25 gear to the crank shaft and so as to prevent the crank
shaft from driving the small gear, thereby performing a

unidirectional transmission between the small gear and the crank shaft.

4. A bicycle as claimed in Claim 1, wherein a sleeve is fixed to the front sprocket, the speed reduction unit including a gear ring being capable of being rotated by the motor shaft, and a ratchet arrangement which is interposed between the gear ring and the crank shaft and which includes:

an inner ratchet wheel and pawl assembly interposed between the crank shaft and the sleeve, and

an outer ratchet wheel and pawl assembly interposed between the sleeve and the gear ring, in such a manner that either of the crank shaft and the gear ring can drive the sleeve when rotating in a direction, and that no rotation can be transferred between the crank shaft and the gear ring.

5. A bicycle as claimed in Claim 1, wherein a sleeve is fixed to the front sprocket, the speed reduction unit including a gear ring being capable of being rotated by the motor shaft, and a ratchet arrangement which is interposed between the gear ring and the crank shaft and which includes:

an inner roller clutch assembly interposed between the crank shaft and the sleeve, and

an outer clutch assembly interposed between the sleeve and the gear ring, in such a manner that either of the crank shaft and the gear ring can drive the

sleeve when rotating in a direction, and that no rotation can be transferred between the crank shaft and the gear ring.

6. A bicycle substantially as described hereinbefore
5 with reference to Fig. 2 to 9B of the accompanying
drawing.

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Amendments to the claims have been filed as follows

1. A bicycle including a frame unit, a front sprocket, a crank shaft for driving the front sprocket, a pedal unit for activating the crank shaft, and an electrical driving device which includes a motor installed on the frame and having a motor shaft, and a speed reduction unit transferring rotation of the motor shaft to the crank shaft, in such a manner that the crank shaft rotates at a speed smaller than that of the motor shaft, and that the crank shaft cannot drive the motor shaft, wherein the improvement comprises:

the motor shaft being coaxial with the front sprocket.

2. A bicycle as claimed in Claim 1, wherein the motor includes a stator and a rotor surrounding the stator and provided with a fixed driving gear which serves as the motor shaft, the speed reduction unit including:

a casing unit fixed on the frame so as to permit the crank shaft to be journalled therein, the motor being disposed within the casing unit;

a left carrier positioned in the casing unit;

a plurality of left planet gears mounted pivotally on the left carrier and meshing with the driving gear of the rotor;

25 a ring gear fixed on the casing unit and meshing with the left planet gears so as to rotate the left carrier in a direction the same as that of the rotor;

a driven gear fixed on the left carrier;

a right carrier;

a plurality of right planet gears mounted pivotally on the right carrier and meshing with the driven gear; and

5 a ratchet unit connecting the right carrier to the crank shaft so as to transfer rotation of the right carrier to the crank shaft and so as to prevent the crank shaft from driving the right carrier, thereby performing a unidirectional transmission between the right carrier and the crank shaft.

10 3. A bicycle as claimed in Claim 1, wherein the motor includes a stator and a rotor surrounding the stator and provided with a fixed driving gear which serves as the motor shaft, the speed reduction unit including:

15 a casing unit fixed on the frame so as to permit the crank shaft to be journalled therein, the motor being disposed within the casing unit;

a large gear mounted rotatably in the casing unit and meshing with the driving gear;

20 a small gear coupled fixedly and coaxially with the large gear and having a diameter smaller than that of the large gear;

25 a ratchet unit connecting the small gear to the crank shaft so as to transfer rotation of the small gear to the crank shaft and so as to prevent the crank shaft from driving the small gear, thereby performing a

unidirectional transmission between the small gear and the crank shaft.

4. A bicycle as claimed in Claim 1, wherein a sleeve is fixed to the front sprocket, the speed reduction 5 unit including a gear ring being capable of being rotated by the motor shaft, and a ratchet arrangement which is interposed between the gear ring and the crank shaft and which includes:

an inner ratchet wheel and pawl assembly 10 interposed between the crank shaft and the sleeve, and

an outer ratchet wheel and pawl assembly interposed between the sleeve and the gear ring, in such a manner that either of the crank shaft and the gear ring can drive the sleeve when rotating in a 15 direction, and that no rotation can be transferred between the crank shaft and the gear ring.

5. A bicycle as claimed in Claim 1, wherein a sleeve is fixed to the front sprocket, the speed reduction unit including a gear ring being capable of being 20 rotated by the motor shaft, and a ratchet arrangement which is interposed between the gear ring and the crank shaft and which includes:

an inner roller clutch assembly interposed between the crank shaft and the sleeve, and

25 an outer clutch assembly interposed between the sleeve and the gear ring, in such a manner that either of the crank shaft and the gear ring can drive the

sleeve when rotating in a direction, and that no rotation can be transferred between the crank shaft and the gear ring.

6. A bicycle substantially as described hereinbefore
5 with reference to Fig. 2 to 9B of the accompanying
drawing.

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The
Patent
Office

-16-

Application No: GB 9608736.6
Claims searched: 1 to 6

Examiner: Robert Crowshaw
Date of search: 4 June 1996

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): B7H (HC, HDR, HDS, HDT, HDV)

Int Cl (Ed.6): B62M 11/14, 11/18, 23/02

Other: Online databases: EDOC, WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A	EP 0559231 A1 (YAMAHA)	
A	US 4402374 (KNUR)	

- X Document indicating lack of novelty or inventive step
Y Document indicating lack of inventive step if combined with one or more other documents of same category.
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